Report of the
Scientific Earthquake Studies Advisory Committee

September 23, 2002

The Scientific Earthquake Studies Advisory Committee was appointed and charged, through Public Law 106-503, to advise the Director of the United States Geological Survey on matters relating to that agency's participation in the National Earthquake Hazards Reduction Program. The committee is to review the USGS Earthquake Hazard Program's roles, goals, and objectives, assess its capabilities and research needs, provide guidance on achieving major objectives, and establish and measure performance goals. A committee report is to be issued to the Director for submission to Congress on or before September 30 each year. The Committee has met twice (May 20-21, 2002 in San Francisco, and August 26-27, 2002 in Golden) and is just beginning to address its charge. Nonetheless, certain items regarding program structure and current trends, successes, challenges, and opportunities are clear to us at this time.

Program Structure and Current Trends

Despite rapid progress in understanding earthquakes and their effects, seismic events remain a serious threat to the security of the nation. Estimated consequences of a "direct hit" on a major metropolitan area include thousands of dead and injured, economic losses in excess of $100 billion, and possible nationwide economic disruption. The National Earthquake Hazards Reduction Program (NEHRP) is a strategic program to reduce risks to lives and property resulting from earthquakes in the United States. Federal agencies involved in the NEHRP include the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the United States Geological Survey (USGS).

The USGS, through its Earthquake Hazards Program, plays the central role in the NEHRP in terms of earthquake monitoring, hazard assessment, and research on earthquake occurrence and effects—bringing science to the public good. Measurements of earthquake locations, magnitudes, and shaking effects are fundamental to public safety, emergency response, and preparedness for future earthquakes. This mission of the USGS transcends the traditional roles of the Department of Interior to manage public lands, and clearly satisfies a national need.

We have learned that the current appropriation for the USGS Earthquake Hazard Program is $47.5 million, and that it is distributed among three functions: monitoring (40 percent), hazard assessment (40 percent), and research on earthquake processes and effects (20 percent). Program funding has remained nearly level for the past decade, has not kept up with inflation, and has not allowed program needs to be fully met. The program also faces a personnel crisis in that few young scientists and engineers are being recruited. Replacement of professional staff has been at a ratio of approximately one person for every four who leave. Furthermore, 66 percent of the Earthquake Hazard Program's employees will be eligible for retirement within 10 years.

Successes

The USGS Earthquake Hazards Program leads the national effort to collect, interpret, and disseminate information on earthquakes throughout the United States, and significant earthquakes worldwide, in support of disaster response, scientific research, national security, earthquake preparedness, and public education. Its products enable the public and private sector to assess earthquake hazards and implement effective mitigation strategies, and their research helps to improve hazard-assessment methods and loss-reduction strategies.

The Earthquake Hazards Program supports community-driven needs by working with state and local governments, other federal agencies, regional earthquake-interest groups, academia, and the private sector. Approximately 25 percent of its funding goes to external earthquake research through competitive grants and cooperative agreements (65 universities, state and local agencies, and companies in 28 states during the past 5 years).

Real-time information, now available on the Web, is of strategic importance for local, state, and federal government agencies, national security, businesses, education, and the general public. The program's response to major earthquakes worldwide, working through the State Department with partners in foreign countries, assists in international disaster aid and in research on the effects of earthquakes.

Estimates of future earthquake hazards are now based on predictive models, including interactions between multiple faults and the prediction of strong shaking using the effects on realistic earth structure. This systems-modeling approach, which uses computational methods to integrate a wide array of laboratory, theoretical, and field studies, rapidly transforms new research results into applied products. Important research results include average time intervals between major earthquakes through geologic dating of prehistoric shocks, and improved earthquake-location techniques that are revealing the internal structure of fault zones at the depths where earthquakes originate.

We believe one of the most visible and strategic applications of the Earthquake Hazard Program research in the past 10 years has been the development of National Hazard Maps. These maps form the basis for earthquake-resistant design and rehabilitation throughout the U.S., and were adopted in building codes in 2000. The maps are based on a standardized methodology, and were vetted by the user community to ensure broad acceptance. Activities in hazard mapping are continuing at a regional level. Detailed maps and databases are being developed for Seattle, Memphis, the San Francisco Bay Area including Silicon Valley, and Southern California.

The Earthquake Hazards Program has served the emergency-response community by capitalizing on advances in technology to enhance earthquake information systems. This is being done through the implementation of the Advanced National Seismic System (ANSS), which is an initiative to modernize and expand earthquake monitoring nationwide, with emphasis on urban areas. The ANSS will provide emergency response personnel with earthquake information within minutes of the event, and engineers with critical information about shaking intensity and building responses. Key products of the

ANSS are Internet-enabled maps (ShakeMaps) that portray regional severity and distribution of ground shaking. These maps, in popular GIS formats, enable emergency responders and utility/transportation system operators to assess quickly areas of likely damage and allocate resources. ShakeMap is now an integral component of emergency response plans in several metropolitan areas (for example, Los Angeles, the San Francisco Bay Area, Salt Lake City, and Seattle), and is expanding to other regions, such as Anchorage.

The Earthquake Hazard Program also has developed information products for the general public and the news media. These products are delivered over the Web and include earthquake location maps, summaries of recent noteworthy events, and an interactive tool called "Did You Feel It," which allows the public to become involved in documenting the extent of damage. These products are an outgrowth of efforts to integrate and modernize regional and national seismic monitoring systems.

We feel the involvement of local communities has been an indicator of success in the past, and will continue in the future. Increasing public awareness of earthquake hazards has enhanced regional preparedness in Memphis, Oakland, and Seattle, in particular, where the USGS has worked with FEMA on their "Project Impact." The use of realistic earthquake scenarios is improving planning by communities for earthquake preparedness and emergency response. Additionally, as the ANSS develops, regional advisory groups are promoting involvement by local communities. Interactions with industry and stakeholders are expected to expand in like manner.

Challenges and Opportunities

Although the accomplishments of the Earthquake Hazards Program are impressive, we have identified several critical challenges and opportunities for which appropriate action is highly recommended at this time.

Challenge – The program's investment in technology is insufficient to implement the existing science. For example, tools developed by the program have fundamentally changed the way reliable earthquake information is delivered and used in emergency response. However, these systems have not been deployed in many high-risk urban areas. Additionally, the systems that have been deployed lack sufficient robustness and redundancy to guarantee success.

Opportunity – Full deployment of the Advanced National Seismic System at the level authorized by Congress will provide the appropriate technological infrastructure for implementing robust emergency-response capabilities in all at-risk urban areas. This modern digital seismic network will expand, modernize, and integrate permanent earthquake monitoring and notification nationwide, with emphasis in urban areas at high to moderate earthquake risk.

Challenge – Too little is known about local earthquake processes, permanent ground deformation, and ground-shaking effects. Because data for earthquake hazard characterization are insufficient in many urban areas, the USGS is unable to predict

accurately the expected ground motions. Consequently, production of earth-science tools needed to reduce risk is proceeding at an inadequate pace.

Opportunity – The ANSS will provide much of the requisite data for characterizing expected levels of ground shaking in future damaging earthquakes. These data will allow pilot studies for high-resolution hazard characterization to be extended to all urban areas at risk. However, though the ANSS will add much to our emergency-response capabilities and understanding of the effects of earthquakes on buildings of various types, there remain many opportunities in the Earthquake Hazard Program to improve hazard assessment. Monitoring efficiency can be increased, particularly through advances in information technology. Focused geologic studies, better soil information, improved attenuation models, and more comprehensive seismic hazard maps will improve our ability to characterize seismic hazards and implement effective mitigation programs.

Challenge – Although substantial progress has been made, a comprehensive physics-based theory of earthquakes—one that adequately predicts earthquake occurrence—does not yet exist. This severely limits our ability to forecast future activity, delimit hazards, and reduce risk.

Opportunity – EarthScope is an initiative for a major research facility, funded by the National Science Foundation, that will complement the USGS Earthquake Hazards Program's efforts to better understand earthquake causes. It involves three components: a mobile seismic array that will investigate the structure and evolution of the North American continent, a network of Global Positioning System receivers and strain meters that will measure the accumulation of strain, much of which is ultimately relieved in earthquakes, and an observatory at depth along the San Andreas fault that will study the physical processes and conditions that control earthquakes. EarthScope will not duplicate or replace ANSS instruments, which are deployed to provide long-term instrumentation for locating and measuring earthquakes and their effects on buildings and lifeline structures in urban areas.

EarthScope heralds a revolution in the earth sciences, and the Earthquake Hazards Program can position itself to take advantage of the data. As the federal agency having statutory responsibility for issuing timely warnings of geologic hazards, the USGS can ensure that the data provided by EarthScope are applied to predictive earthquake science and risk reduction.

Challenge – The effectiveness of the Earthquake Hazards Program in the context of NEHRP requires improved national coordination of regional efforts, better integration of earthquake science and engineering, and a more substantial interface between earthquake science and end-users of this science. National coordination is a challenge, because the USGS is a regionally structured agency within a federal department primarily focused on public-land management.

Opportunity – The Earthquake Hazards Program can enhance interactions between NSF-funded programs, including earthquake engineering research centers and the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). It can expand

strategic partnerships with FEMA, and the organizations responsible for development of building codes. These relationships will promote integration and implementation of the Earthquake Hazards Program's science and engineering. Additionally, improving the integration of research and development across regional USGS offices will enable the necessary cohesiveness to enhance program objectives.

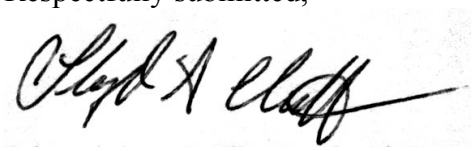
Recommendations

We have two primary recommendations for the USGS Earthquake Hazards Program at this time.

1. Continue to seek full funding at the authorized level for the Advanced National Seismic System.

2. Develop means internally to take advantage of the EarthScope data and research opportunities for earthquake science, and risk reduction.

Respectfully submitted,



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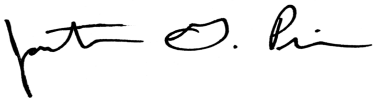

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